Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

Thuidium microphyllum (Lindb.) Best.
"   *recognitum* B. & S.
Sphagnum cymbifolium (Ehrh.) Hedw.
"   *squarrosum* Pers.
"   *acutifolium* Ehrh.
"   "   var. *rubellum* (Wils.) Russ.
"   "   " *quinquefarinum* Lindb.
"   *intermedium* Hoffm.
"   *cuspidatum* Ehrh.

Brooklyn, N. Y.

LICHEN NOTES No. 3.

"Chemical Tests" in Determining Lichens.

G. K. Merrill.

In 1866 the late Dr. William Nylander published the results of his experiments regarding the behavior of certain aqueous chemical solutions, when applied to the cortical and medullary layer of the lichen thallus. The chemical menstrua found most effective and useful were potassium-hydrate and calcium hypochlorite, symbolized as KHO and CaCl. The results obtained hinged on a capacity of the solutions employed to produce a coloration on application to that portion of the thallus to be tested. Dr. Nylander claimed to have found that different lichen species were differently affected by the reagent employed, but that individuals of one species were constant in the production of a given reaction. The object of the test was to assist "in not only the discrimination of many difficult and closely allied species, but also in associating varieties with their proper species, and in some instances in defining the affinities of genera."

The novelty of constituting botanical varieties on purely chemical grounds aroused antagonism at the time, which has persisted more or less to the present day, but the unquestionable value of the discovery as an aid in the determination of established species, made converts of nearly the whole body of European lichenists. Among those to negative the value of "chemical tests" from the first, was the late Prof. Edward Tuckerman, and it is regretfully stated that his views were adopted with great uniformity by the later American investigators. It will be of interest to quote from the published words of those Americans who have written on this topic.

In the American Naturalist for April, 1868, Tuckerman first voiced the disapproval, and we will selectively quote from his paper. Under the caption, "Can Lichens be Identified by Chemical Tests?" he says: "I have gone through a large part of my North American and exotic lichens in the light afforded by these (Nylander's) experiments and found the facts, if sometimes suggestive of more than is stated, generally clear: much clearer than the value attributed to them. Is it not indeed safe to say at once that species are not determined in botany by such tests?" "The observations cited are however incomplete; and derive from this not a little of their interest. *Parmelia perlata* is thus said to differ from its var. *olivetorum* Ach. by failing to show any red tinge with chloride of lime, the difference already recognized being regarded as sufficiently corroborated by the new one. But all specimens of *P. olivetorum* are not so distinguishable. It is much the same with *P. lævigata* and its var. *revoluta* Nyl. (Syn. p. 385), the last being now taken and on better evidence to be distinct in species from the first. We have here a better marked difference in botanical character, one which commended itself as sufficient to Floerke, and at one time to Borrer; and there seems to be no doubt that the original *P. revoluta* Flk. is discrepant from common states of *P. lævigata* in the chemical respect also."

The learned author goes on to say that all his European specimens of *P. tiliacea* afford a distinct reaction, with which only two or three of the relatively abundant American forms are concurrent. He also finds that Arctic, Tropical and Texan forms of *P. caparata* give a plus reaction when they should be minus; that *P. physodes Japonica* Tuckerm. is plus when the *physodes* group is conceded to be minus: and that while *P. Borreri* is recorded as plus. no reaction is observable with the specimens in his herbarium. The concluding lines of the paper are interesting. for Tuckerman affirms that, "these results given with due respect to the experienced authors whose observations have been considered, sufficiently indicate that the writer inclines to emphasize the doubts with which Dr. Fries has received the supposed new criteria of distinction. It remains none the less likely from what evidence we have that the reagents named, capable as they are of instructive application to imperfect fragments, may sometimes afford clews to affinity where there is little to direct: and thus deserve a place besides the better known solution of Iodine on our working tables."

In the Genera Lichenum, 1872, Tuckerman in discussing the tendency of the Europeans toward species splitting, reiterates his disapproval of chemical tests. Referring to what he terms a "laxity of conception" regarding specific delimitation, he says, "This is seen at least in the very generally assumed value of recent experiments on the behavior of lichen-tissues with certain chemical tests: species having come at last to have no other meaning than a chemical one: namely, that they exhibit (so far, it is important to say, as the examination has gone) a different reaction from forms with which, in every other respect, they are admitted to agree."

In his Synopsis, Pt. 1, 1882, Tuckerman makes no general allusion to chemical tests, such remarks as are noted being limited to instances of perversion from the recorded results of the Europeans. It is easy to see that chemical tests are viewed with hostility, although his attitude is evidently a passive one. In an extract from the Botanical Gazette, April, 1896, Mr. Henry Willey, of New Bedford, Mass., briefly takes up the matter of chemical tests in relation to the genus Parmelia. The paper, which is entitled, "Notes on Some North American Species of Parmelia," catalogues the reactions for a number of species, the reagents employed being potassium-hydrate and calcium hypochlorite. Willey remarks, "Of the chemical relations I am unable to attach absolute specific value to them. There are exceptions to their constancy, some of which were pointed out by Tuckerman in a paper in the Am. Nat., April, 1868. It is possible that a lichen may possess different chemical constituents at different stages of growth, or under different conditions of soil, climate, etc. Experiment on the same plant at different periods of its development is necessary to confirm the deductions from simple examination. Still, the reactions appear to be constant in most of the species of Parmelia and may serve as an aid in their determination, while the exceptions remain to be accounted for. Where there appears to be an exception we may best say that *perhaps* the specimen belongs to a distinct species."

Prof. Albert Schneider, in his Text Book of Lichenology, 1897, says of chemical reactions: "For some years the chemical behavior of lichens to certain reagents has been considered of great importance in delimiting species. After careful testing I have finally decided to abandon the use of these reagents since they are practically valueless for the purpose recommended. That there are marked chemical reactions cannot be denied: for example, the blue Iodine reaction of the thecial wall of the majority of lichens. This reaction is, however, so general in its occurrence that it cannot possibly be of any value in establishing species, and the coloration varies in different individuals of the same species, or even of the same plant at different periods of development. The same may be said of the other reactions as those with solutions of potassium-hydrate and calcium hypochlorite. That these reactions should be unreliable is evident when we consider the life history of lichens; different individuals of one and the same species may develop on substrata of widely different composition. These chemically different substances adhere to the lichens, and some soluble constituents are also taken up by the fungal symbiont which accounts for the difference and unreliability of the chemical reactions.

Prof. Bruce Fink, in his Presidential address to the Iowa Academy of Sciences, pays his respects to the subject through an allusion to Dr. Nylander. He says: "Nylander was doubtless too much given to species making, and it is unfortunate that he depended too much on chemical tests in his determinations." A few pages further on Fink, in alluding to Tuckerman's expressed opinion of the unreliable nature of chemical tests adds, that such is "a view which I suppose meets the approval of later lichenists generally, since we have reached more definite knowledge regarding the anatomy of these plants." In another paper presented before the same Institution entitled, "Notes on American Cladonias," Prof. Fink says, "as to chemical tests it is extremely doubtful whether they are of diagnostic value in any lichen." The writer will add to these excerpts of American opinion on chemical tests, the information communicated by Prof. W. G. Farlow, of Harvard University, that Tuckerman "never changed his opinion in later years with regard to use of chemical tests in distinguishing species of lichens. He did not consider that species could be distinguished in that way."

To summarize the foregoing expressions of opinion is to assort belief into two groups. Schneider and Fink are associable in the first, for both repudiate chemical tests altogether. Tuckerman and Willey comprise the second, each conceding the chemical test to be of more or less value in determining established species, but dissenting from the view that the establishment of specific botanical varieties on chemical grounds is possible without such are confirmed by morphological characteristics. The writer has no personal knowledge of the extent to which Fink and Schneider have carried their experiments with reagents. The latter indeed says that his investigations were pursued to a point where he was convinced of their futility, but Fink fails to specify. It might be assumed from the fact that neither gentleman is at all reserved in his statements, that they have delved deeper than did Tuckerman or Willey. It would be an interesting contribution to American lichenological literature if one or both should set forth *ab initio* the successive discoveries leading to their conclusions as published.

With the guardedness which was characteristic of the man, Tuckerman, in the 1868 paper, after having boldly condemned chemical tests, is finally found to qualify his conclusions. In the concluding lines he admits that the "instructive application of reagents to imperfect fragments might sometimes afford clews to affinity." If chemical tests may be relied on in determining fragments, it is suggestive that if the investigator were working on a satisfactory specimen the results might be proportionally superior.

Dr. Th. M. Fries, whom Tuckerman quotes as offering opposition to the new tests, according to Leighton soon came to believe in their value, and his personal experiences are found incorporated in "Lichenes Spitzbergenses," and "Lichenographia Scandinavica." After Tuckerman's death Willey entered into closer relations with the European lichenists. One result of his correspondence with Nylander may be gathered by a persusal of the notes on Parmelia, l. c. In this paper Willey states that "there appear to be known about forty species" of Parmelia in North America, as contrasted with nineteen mentioned in Tuckerman's Synopsis. He acknowledges that many of the new names were the result of Nylander's examination of New Bedford and other material, and that the separation hinged on "chemical or other grounds." The paper contains some admissions that might easily be taken as evidence that Willey had shaken off the mantle of conservatism and joined the enemy, if it were not for his explicit statement of inability to "attach absolute specific value" to the chemical relations. All who have had any personal acquaintance with Willey will agree that if he ever attached to the specimens of his herbarium a name prompted by Nylander it was done with full knowledge of the masters' position on the chemical phase of species making; and such a course must be regarded as a tacit avowal of belief. A curious point may be made from Willey's paper to illustrate the notorious diversity of results obtained with reagents in the hands of different experimenters. Tuckerman referred to his results with various species of Parmelia to show their discrepancy from published findings; and Willey remarks that the "reactions appear to be constant in most of the species of Parmelia," and then adds that the fact "may serve as an aid to their determination." Here is a clear discordance of opinion with no explanation ready at hand. It is difficult to believe that the lack of conformity is due to a difference in interpretation of fact, nor is it thought to be an effect of similar specific lichen forms furnishing dissimilar phenomena. A possible explanation may be that Willey, under the guidance of Nylander, came to have a better knowledge of Parmelia species than did Tuckerman, and a more exact conception of the things to be recognized in chemical testing.

The student on first taking up the subject of chemical criteria is apt to find it difficult to exactly determine what constitutes a satisfactory test. The manuals contain fairly clear directions, but mere words only convey an outline, leaving experience to supply the details. There are some temperamentally unfitted to make use of the tests, and others, solitary workers, without guidance except for the books. Both fail from obvious reasons. In their inception chemical tests were only recommended as aids to the characterization of lichens, and much of the early antagonism to their employment is attributed to a misapprehension of their point. In the Annals and Magazine of Natural History, 1869, Rev. W. A. Leighton (Not. Lich. XVIII) in reviewing Dr. Th M. Fries' Lichenes Spitzbergenses, takes occasion to say, "With much satisfaction we observe that the learned author has overcome his prejudice against the application of chemical tests in lichens, and has made ample use of them with very satisfactory results. He, however, still appears to labor under a misapprehension that the advocates of chemical tests wish to inculcate that species may be distinguished by chemical means alone (hac sola nota). All that has ever been ascribed to them is that they are most useful and indispensable aids as affording confirmatory characters and in discriminating doubtful or externally allied species. In the Cladoniae he has almost uniformly confirmed the results of our own examination of the tribe. But it may be well here to correct a doubt which seems to exist in consequence of the chemical test producing in certain species a slight degree of fuscescence only, by explaining that when the proper reaction takes place it does so instantly, and that the fuscescence which is in some instances observable is not to be regarded as a reaction at all."

In the same publication for 1869, Leighton (Not. Lich. XXIX) again writes, "The student is especially warned against misconception as to chemical tests constituting a sole specific character. All that has ever been asserted respecting them is that they afford an *additional* and *confirmatory specific character*. And in those cases where external characters are similar or approximate, and doubt necessarily exists, their value as such will be abundantly apparent." Leighton then proceeds to quote from a paper by Dr. Nylander, aptly designating the citation as an "admirable caution." The learned Doctor says: "The analysis of lichens made by chemists often fail through the neglect of an exact determination of the species, and probably not less often by the mixture of specimens confounded together and incorrectly assigned to one single species. For the chemist no less than for the physiologist it is of the greatest importance to know exactly what is the plant we have under observation—that is, to have well determined the plant which we are studying." In other words, returning to Leighton, "he must not place implicit confidence on the attached labels as indicating undoubted accuracy, or on his own preconceived notion of the particular diagnosis, but by careful observation and comparison thoroughly satisfy himself that the plant under review is really that which the label indicates it to be. Then apply the chemical test and doubt will be exchanged for certainty."

Leighton is far from clear in the last sentence—perhaps his meaning is that in the hands of the other experimenters, comparison of their own results with records of accurate work might produce a feeling of certainty. A determination that is established beyond question on other grounds, needs no chemical bolstering. In the light of the foregoing the whole question of the usefulness of chemical tests to lichen students resolves itself on the real or presumed ability and knowledge of whomsoever may have made the primary series of tests. No one will gainsay Dr. Nylander's standing as a lichenist, or question his knowledge of lichen species, whatever the aspect. Is it not reasonable to say as Nylander was learned beyond all men in lichenology, aud well enough acquainted with species to be enabled at all times to dispense with chemical tests, that whatever conclusions he reached in his searching investigations into reagents and their application, should be regarded as convincing? If Nylander, or. for that matter, any accomplished lichenist, should examine an extended series of specimens of a morphologically proven species, these from widely separate localities and various substrata, and on application of reagents find that all gave the same coloration, how might the sceptic best refute such results? Would the statement of the doubting one, that in his hands no such uniformity was obtained, have any controversial value? We think not, except to himself. Tuckerman was primarily responsible for the determination of most of our American lichen species, and up to the time of his death very few looked beyond his opinion. It then seems like a violation of things sanctified to express the belief that no small part of the failure of our students to obtain concurrent reactions in tests, has been due to application of reagents to plants of species other than what the investigator supposed he was examining.

The writer will add a few notes on matters of practice in using the reagents. Instead of employing a glass brush as recommended by Leighton, a medicine dropper is used. In cases where no distinct coloration of thallus or medulla is observable on application of the solution, if it is withdrawn from the surface of the specimen within the tube it will sometimes be found tinged and may then be taken for a very delicate test. It is advisable in testing with calcium hypochlorite, after application, to examine the thallus where abraded, with a hand-lens. The coloration is sometimes very faint, and only thus to be distinguished. In conclusion, it may be said that in our hands chemical tests have proven all that the French lichenists assert, but we desire it to be understood that in no way are we in sympathy with "chemical species."

Rockland, Maine.

SULLIVANT MOSS CHAPTER NOTES.

Four names are to be added this month to our list of Chapter Members: Mr. Hollis Webster, 16 Prentiss street, North Cambridge, Mass: Mr. Shutai Okamura, 1st Middle School, Kochi, Kochi-Ken, Japan; Mons. T. Renauld, 3 Rue Miron, Nice, France: Miss Mary A. Brackett, 50 Remsen street, Brooklyn, N. Y. Making our total membership now 175.